100/100 MARKS

ARTHAM
RESOURCE MATERIAL
NO. 1 EDUCATIONAL RESOURCES

NCERT
CHAPTER WISE
TOPIC WISE
LINE BY LINE QUESTIONS
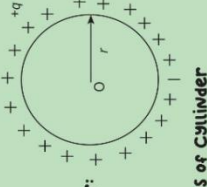### 2024

BY
SCHOOL OF
EDUCATORS

CAPACITOR

KIRCHOFF'S LAW OF CAPACITOR'S

FIRST LAW: This law is basically law of conservation of charge which states that the sum of incoming charges at a function in equal to the sum of outgoing charges

$$q_- = q_1 + q_2 = q_3 + q_4$$

SECOND LAW: In a closed loop, the summation of all the potential differences must be zero.

$$V - \frac{q_1}{C_1} - \frac{q_3}{C_3} = 0$$

COMBINATION OF CAPACITOR'S

- Series equivalent of Capacitor's $\theta = C_1 V_1 = C_2 V_2$

In Series $V_0 = V_1 + V_2$

$$\frac{1}{C_{equi}} = \frac{1}{C_1} + \frac{1}{C_2}$$

- Parallel Equivalent of Capacitor's

In parallel $V = V_1 = V_2$

$$\theta = \theta_1 + \theta_2$$

$$C_{equiv} = C_1 + C_2$$

CAPACITOR WITH DIELEATRIC

- Capacitance of capacitor having dielectric constant (k) and (t<d):

$$C = \frac{A\varepsilon_0}{dd - t + \frac{t}{k}} \quad \begin{array}{l} t = thickness \\ k = Dieletric \\ \quad Constant \end{array}$$

- Capacitance of Capacitor having dielectric constant (K) and (t = d):

$$C = \frac{A\varepsilon_0}{d - d + \frac{d}{k}} = \frac{kA\varepsilon_0}{d} = kC_0$$

ELECTROSTATIC PRESSURE

$$(P) = \frac{F}{A} = \frac{\theta E}{A} = \frac{\sigma A}{A} \left(\frac{\sigma}{2\varepsilon} \right)$$

$$= \frac{1}{2} \frac{\sigma^2}{\varepsilon_0}$$

DIELECTRIC

Dielectric is a material which behaves as non conductor upto certain value of external electric field. If the field crosses the limiting value (called dielectric strength) then it beging to conduct.

Dielectric constant (k or E_R)

$$\varepsilon_r = K = \frac{E_m}{\varepsilon_0}$$

NON-POLAR DIELECTRIC

- Centers of +ve and –ve charge coincide due to symmetric shape of molecules.
- Each molecue has permanent dipole moment only in presence of External electric field

POLAR DIELECTRIC

- Centers of +ve and –ve charge do not coincide due to asymmetric shape of molecules.
- Each molecue has permanent dipole moment in presence of External electric field

A capacitor is a device which can store more electric charge or potential energy compared to on isolated conductor

- Capacitance: Capacitance of a conductor measure of its ability to store charge.

$$V\infty q \Rightarrow V = \frac{q}{C} \Rightarrow C = \frac{q}{V}$$

S.I. Unit Farad (F) $= \frac{Coulomb}{Volt}$

FORCE BETWEEN THE PLATES OF CAPACITOR

$$\frac{\theta \tau}{2\varepsilon_0} \Rightarrow F = \frac{\theta^2}{2A\varepsilon_0} = \frac{1}{2}\varepsilon_0 A E^2$$

$F = force: \theta = charge$

$E = electric field between plates$

$\sigma = surface charge density$

ENERGY STRORED IN A CHARGED CAPACITOR

$$U = \frac{1}{2}\frac{\theta^2}{C} = \frac{1}{2}CV^2 = \frac{1}{2}\frac{\theta V}{2} = \frac{\theta V}{C}$$

WORK DONE BY BATTERY DURING CHARGING OF A CAPACITOR

$$\Rightarrow w_{Battery} = \theta C = CV^2 = \frac{\theta}{C}$$

ENERGY DENSITY OF CAPACITOR

Energy stored in the capacitor per unit volume.

Energy density of

$$capacitor = \frac{dV}{dV}$$

$$\frac{\frac{1}{2}CV^2}{A \times d} = \frac{1}{2}\varepsilon_0 F^2$$

$$\Rightarrow \left(\frac{U}{V} \right) = \frac{1}{2}\varepsilon_0 F^2$$

TYPES OF CAPACITANCE'S

- Capacitance of Spherical conductor:

$$C = 4\pi\varepsilon r$$

- Capacitance of Earth: $C = 4\pi\varepsilon r; \ r = 6.4 \times 10^6 F$

$$\therefore C = 4\pi \times 8.854 \times 10^{-12} \times 6.4 \times 10^6 = 7.11 \times 10^{-4} F$$

- Capacitance of Parallel Plate Capacitor:

$$(C_0) = \frac{\varepsilon_0 A}{d} F$$

where— $\varepsilon_0 = Free Space Permitivity$

and $A = Plate Area$

$d = Sepration between Plates$

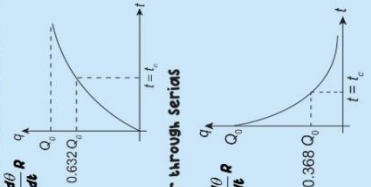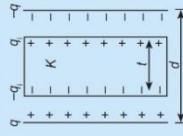## OTHER TYPES OF CAPACITOR'S

- Spherical Capacitor outer surface Earthed:

$$C = \frac{4\pi\varepsilon_0}{\frac{1}{R_1} - \frac{1}{R_2}}$$

- Cylindrical Capacitor:

$$C = \frac{4\pi\varepsilon_0 L}{\ln\left(\frac{b}{a}\right)}$$

L, B and a – Parameters of Cylinder

CHARGING & DISCHARGING OF A CAPACITOR

- CHARGING:
(i) Charging of a capacitor without Resistance
Charging take no time when Switch closed
$$q_0 = CV$$
(ii) Charging of a Capacitor having series Resistance:

$$V_0 = V_c + V_R = \frac{\theta}{C} + IR = \frac{\theta}{C} + \frac{d\theta}{dt}R$$

$$q = CV_0 E^{-\frac{t}{RC}} = q_0 e^{-\frac{t}{\tau}}$$

I = Current.
R = Resistance
T = Time Constant = RC

- Discharging of a capacitor through series resistance:

$$V_0 = V_c + V_R = \frac{\theta}{C} + IR = \frac{\theta}{C} + \frac{d\theta}{dt}R$$

$$\theta = \theta_0 (1 - e^{-\frac{t}{\tau}})$$

$$\theta = 0.368\theta_0$$

At time $t = RC$

NCERT LINE BY LINE QUESTIONS

1. An electric point charge q = $6\,\mu\text{C}$ is placed at origin of x - y Co-ordinate axis. Calculate electric potential due to the charge at point P(12m, 16m) in free space.

   (a) 1.2 kV   (b) 2.3 kV   (c) 3.7 kV   (d) 2.7 kV

2. The comparative graph of potential and electric field due to a point charge at a distance r from it is best shown by graph.
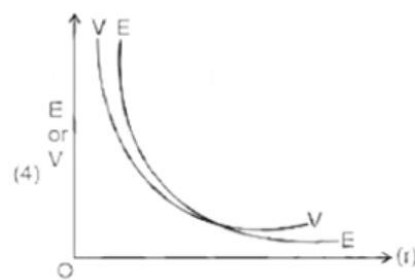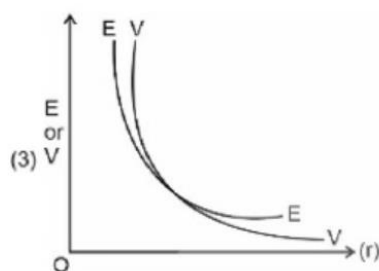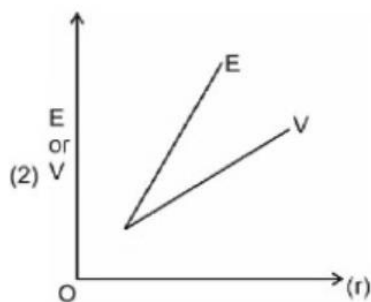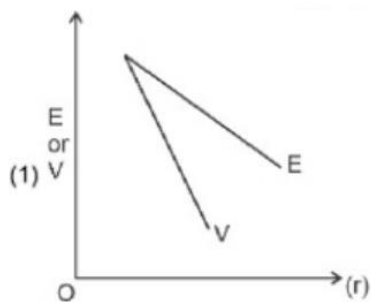
3. A point charge $Q = 4 \times 10^{-7}\,\text{C}$ is placed at a point in free space. How much work is required to bring a charge 2nC from infinity to a point 9cm from charge Q ?

   a) $3 \times 10^{-4}\,\text{J}$ b) $8 \times 10^{-5}\,\text{J}$ c) $2 \times 10^{-5}\,\text{J}$ d) $5 \times 10^{-5}\,\text{J}$

4. Which among the following statements is an incorrect statement ?

   (a) The electric dipole potential falls off, at large distance, as $1/r^1$

   (b) The electric potential due to dipole in the equatorial position is zero

   (c) The electric potential due to dipole has axial symmetry about dipole moment vector p

   (d) Electric potential on dipole axis is maximum.

5. Two charges 6 nC and -4 nC are located 15 cm apart. At what point on line joining two charges is electric potential zero?

   (a) 6 cm from 6 nC charge   (b) 45 cm from 6 nC charge

   (c) 38 cm from 6 nC charge   (d) 9 cm from -4 nC charge

6. The incorrect statement regarding equipotential surface is

   (a) Equipotential surface through a point is normal to electric field at that point

   (b) An equipotential surface is a surface with a constant value of potential at all points on the surface

   (c) Equipotential surfaces of a single point charge are concentric spherical surfaces centred at the charge

   (d) For uniform electric field along x-axis, equipotential surfaces are planes parallel x - y plane

7. Work done by external agent in assembling three identical charges from infinity to given locations is
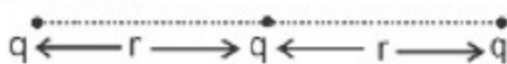
a) $\dfrac{5}{8\varepsilon_0}\dfrac{q^2}{r}$
b) $\left(\dfrac{5}{8\pi\varepsilon_0}\dfrac{q^2}{r}\right)$
c) $\dfrac{5}{2\pi\varepsilon_0}\dfrac{q^2}{r}$
d) $\dfrac{3q^2}{8\pi\varepsilon_0 r}$

8. Two point charges $7\,\mu C$ and $-2\,\mu C$ are placed at position $(-9cm, 0)$ and $(9cm, 0)$ respectively. How much work is required to separate two charges infinitely away from each other ?

a) 0.2 J
b) 0.5 J
c) 0.6 J
d) 0.7 J

9. A dipole with dipole moment 310^{-9} C m is placed in external uniform field of E = $4\,10^5$ N C^{-1} . Calculate amount of work done by field in rotating the dipole from $\theta = 60°$ to $0°$. (θ is angle between electric field E and dipole moment vector)

(a) 200μ J
(b) 600μ J
(c) 300μ J
(d) 90μ J

10. When a conductor is placed inside uniform electric field. Then
(a) At the surface of conductor, electrostatic field is normal to the surface at every point.
(b) Inside the conductor, electrostatic field is zero.
(c) The electrostatic potential is constant throughout the volume of conductor and has the same value on its surface
(d) All of above are correct

11. Two conductors are separated by distance of 1 cm in air. The dielectric strength of air is about 310^6 Vm^{-1}. What maximum safe potential difference can be applied across conductors?

(a) $3\times10^4\,V$
(b) $6\times10^4\,V$
(c) $3\times10^6\,V$
(d) $1.5\times10^4\,V$

12. A slab of material having dielectric constant K = 1.5 has the same area as of a plates of parallel plate capacitor but has thickness $\dfrac{3}{4}$ of plate separation is introduced between the plates of the capacitor having capacitance C. On introducing slab, capacity becomes factor of

a) $\dfrac{12}{7}C$
b) $\dfrac{5}{7}C$
c) $\dfrac{6}{7}C$
d) $\dfrac{4}{3}C$

13. A network of four capacitors each $10\,\mu F$ are connected as shown with 500V supply. Calculate the ratio of charges stored on C_4 and C_2
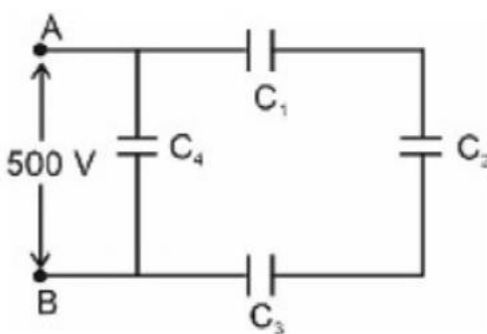

(a) 1
(b) $\dfrac{1}{2}$
(c) $\dfrac{1}{3}$
(d) 3

14. A 900 pF parallel plate capacitor is charged by 100 V ideal battery. The space between the plates is 1cm. How much electrostatic energy is stored per unit volume of empty space of capacitor?
    (a) $4.42 \times 10^{-4} \, \text{Jm}^{-3}$
    (b) $8.85 \times 10^{-6} \, \text{Jm}^{-3}$
    (c) $2.21 \times 10^{-7} \, \text{Jm}^{-3}$
    (d) $6.2 \times 10^{-6} \, \text{Jm}^{-3}$

15. A 90 pF capacitor is charged by a 10 V battery. The capacitor is then disconnected from battery and connected to another charged 90 pF capacitor. Final electrostatic energy stored by the system is
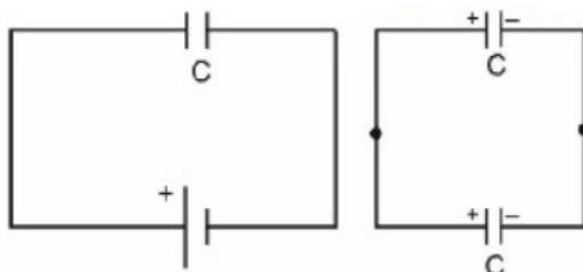
    (a) 225 pJ
    (b) 2.25 nJ
   (c) 4.5 pJ
    (d) 4.5 nJ

16. A parallel plate capacitor is charged by a battery. Now battery is removed and medium between the plates of the capacitor is filled with an insulating material of dielectric constant K, then
    (a) Electric field due to charged plates induces a net dipole moment in the dielectric (insulating material)
    (b) Net potential difference between the plates is reduced
    (c) Capacitance C decreases from initial value C_o to (C_o/K)
    (d) Both (a) and (b) are correct

17. A parallel plate capacitor with each plate of area $6 \times 10^{-3} \text{m}^2$ has plate separation of 3 mm. A 3 mm thick mica sheet of dielectric constant K = 6 was inserted between the plates. If this capacitor is connected to 100 volt supply, what is charge on positive plate of capacitor?

    (a) $1.92 \times 10^{-9} \text{C}$
    (b) $1.06 \times 10^{-8} \text{C}$
    (c) $4.2 \times 10^{-8} \text{C}$
    (d) $4.36 \times 10^{-7} \text{C}$

18. Equivalent capacitance of the network across points A and B is
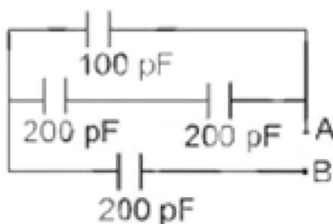
    (a) 200pF
    (b) l50pF
    (c) 100 pF
    (d) 700 pF

19. A spherical capacitor consists of two concentric spherical conductors held in position by filling insulating material of dielectric constant 6. The inner sphere has radius of 10 cm and outer has 40 cm. The capacitance of spherical capacitor is
    (a) 100 pF
    (b) 108 pF
    (c) 88.8 pF
    (d) 73.3 pF

20. A parallel plate capacitor is to be designed with a voltage rating of 2 kV, using a material of dielectric constant 3 and dielectric strength about 12×10^6 Vm⁻¹, for safety we should like the field never exceed 20% of dielectric strength. What minimum area of plate is required to have capacitance of 60 pF?

(a) $1.2 \times 10^{-6} \, m^2$ (b) $4.75 \times 10^{-4} \, m^2$ (c) $1.88 \times 10^{-3} \, m^2$ (d) $5.65 \times 10^{-3} \, m^2$

21. The electric potential inside a conducting sphere
    (a) increases from centre to surface
    (b) decreases from centre to surface
    (c) remains constant from centre to surface
    (d) is zero at every point inside

22. It becomes possible to define potential at a point in an electric field because electric field
    (a) is a conservative field
    (b) is a non-conservative field
    (c) is a vector field
    (d) obeys principle of superposition

23. Which of the following about potential at a point due to a given point charge is true ?
    The potential at a point P due to a given point charge
    (a) is a function of distance from the point charge.
    (b) varies inversely as the square of distance from the point charge.
    (c) is a vector quantity.
    (d) is directly proportional to the square of distance from the point charge.

24. Which of the following quantities do not depend on the choice of zero potential or zero potential energy?
    (a) Potential at a point
    (b) Potential difference between two points
    (c) Potential energy of a two-charge system
    (d) None of these

25. A cube of a metal is given a positive charge Q. For this system, which of the following statements is true?
    (a) Electric potential at the surface of the cube is zero
    (b) Electric potential within the cube is zero
    (c) Electric field is normal to the surface of the cube
    (d) Electric field varies within the cube

26. A unit charge moves on an equipotential surface from a point A to point B, then
    (a) $V_A - V_B = + \, ve$ (b) $V_A - V_B = 0$
    (c) $V_A - V_B = - \, ve$ (d) it is stationary

27. The electric potential at a point on the equatorial line of an electric dipole is
    (a) directly proportional to distance
    (b) inversely proportional to distance
    (c) inversely proportional to square of the distance
    (d) None of these

28. The potential energy of a system of two charges is negative when
    (a) both the charges are positive
    (b) both the charges are negative
    (c) one charge is positive and other is negative
    (d) both the charges are separated by infinite distance

29. An electric dipole of moment $\vec{p}$ is placed normal to the lines of force of electric intensity , $\vec{E}$ then the work done in deflecting it through an angle of 180° is
    (a) pE (b) $+2pE$ (c) $-2pE$ (d) zero

30. Which of the following about potential difference between any two points is true?
    I. It depends only on the initial and final position.
    II. It is the work done per unit positive charge in moving from one point to other.
    III. It is more for a positive charge of two units as compared to a positive charge of one unit.
    (a) I only   (b) II only
    (c) I and II   (d) I, II and III

31. An electric dipole of moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$. Then which of the following is/are correct?
    I. The torque on the dipole is $\vec{p} \times \vec{E}$
    II. The potential energy of the system is $\vec{p}.\vec{E}$
    III. The resultant force on the dipole is zero.
    (a) I, II and II   (b) I and III

32. Match the entries of Column I and Column II

Column I	Column II
(A) Inside a conductor placed in an external electric field.	(1) Potential energy = 0
(B) At the centre of a dipole	(2) Electric field = 0
(C) Dipole in stable equilibrium	(3) Electric potential = 0
(D) Electric dipole perpendicular to uniform electric field.	(4) Torque = 0

    (a) (A) → (2); (B) → (4); (C) → (3); (D) → (1)
    (b) (A) → (2); (B) → (3); (C) → (4); (D) → (1)
    (c) (A) → (2); (B) → (3); (C) → (1); (D) → (4)
    (d) (A) → (1); (B) → (3); (C) → (4); (D) → (2)

33. If a unit positive charge is taken from one point to another over an equipotential surface, then
    (a) work is done on the charge   (b) work is done by the charge
    (c) work done is constant   (d) no work is done

34. On decreasing the distance between the plates of a parallel plate capacitor, its capacitance
    (a) remains unaffected   (b) decreases
    (c) first increases then decreases.   (d) increases

35. Energy is stored in a capacitor in the form of
    (a) electrostatic energy   (b) magnetic energy
    (c) light energy   (d) heat energy

36. If in a parallel plate capacitor, which is connected to a battery, we fill dielectrics in whole space of its plates, then which of the following increases?
    (a) Q and V   (b) V and E   (c) E and C   (d) Q and C

37. When air in a capacitor is replaced by a medium of dielectric constant K, the capacity
    (a) decreases K times   (b) increases K times
    (c) increases K^2 times   (d) remains constant

38. A conductor carries a certain charge. When it is connected to another uncharged conductor of finite capacity, then the energy of the combined system is
    (a) more than that of the first conductor
    (b) less than that of the first conductor
   (c) equal to that of the first conductor
    (d) uncertain

TOPIC WISE PRACTICE QUESTIONS

Topic 1: Electrostatic Potential and Equipotential Surfaces

1. The electric potential inside a conducting sphere
   (a) increases from centre to surface
   (b) decreases from centre to surface
   (c) remains constant from centre to surface
   (d) is zero at every point inside

2. A unit charge moves on an equipotential surface from a point A to point B, then
   (a) $V_A - V_B = + ve$
   (b) $V_A - V_B = 0$
   (c) $V_A - V_B = - ve$
   (d) it is stationary

3. Consider a finite insulated, uncharged conductor placed near a finite positively charged conductor. The uncharged body must have a potential :
   (a) less than the charged conductor and more than at infinity.
   (b) more than the charged conductor and less than at infinity.
   (c) more than the charged conductor and more than at infinity.
   (d) less than the charged conductor and less than at infinity.

4. Two concentric spheres of radii R and r have similar charges with equal surface charge densities (σ). What is the electric potential at their common centre?
   (a) σ / ε_0
   (b) $\dfrac{\sigma}{\varepsilon_0}(R - r)$
   (c) $\dfrac{\sigma}{\varepsilon_0}(R + r)$
   (d) None of these

5. From a point charge, there is a fixed point A. At A, there is an electric field of 500 V/m and potential difference of 3000 V. Distance between point charge and A will be
   (a) 6 m
   (b) 12 m
   (c) 16 m
   (d) 24 m

6. Four points a, b, c and d are set at equal distance from the centre of a dipole as shown in a figure. The electrostatic potential V_a, V_b, V_c, and V_d would satisfy the following relation:
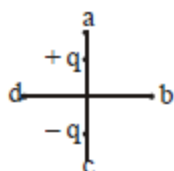

   (a) $V_a > V_b > V_c > V_d$
   (b) $V_a > V_b = V_d > V_c$
   (c) $V_a > V_c = V_b = V_d$
   (d) $V_b = V_d > V_a > V_c$

7. Charges are placed on the vertices of a square as shown. Let $\bar{E}$ be the electric field and V the potential at the centre. If the charges on A and B are interchanged with those on D and C respectively, then
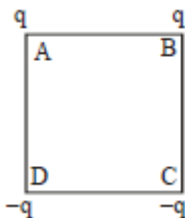
   (a) $\bar{E}$ changes, V remains unchanged
   (b) $\bar{E}$ remains unchanged, V changes
   (c) both $\bar{E}$ and V change
   (d) $\bar{E}$ and V remain unchanged

8. Two metal pieces having a potential difference of 800 V are 0.02 m apart horizontally. A particle of mass 1.96×10^{-15} kg is suspended in equilibrium between the plates. If e is the elementary charge, then charge on the particle is
   (a) 8
   (b) 6
   (c) 0.1
   (d) 3

9. The electric potential V (in Volt) varies with x (in metres) according to the relation $V = (5 + 4x^2)$. The force experienced by a negative charge of 2×10^{-6} C located at x = 0.5 m is
   (a) 2×10^{-6} N   (b) 4×10^{-6} N   (c) 6×10^{-6} N   (d) 8×10^{-6} N

10. The 1000 small droplets of water each of radius r and charge Q, make a big drop of spherical shape. The potential of big drop is how many times the potential of one small droplet?
    (a) 1   (b) 10   (c) 100   (d) 1000

11. Which of the following figure shows the correct equipotential surfaces of a system of two positive charges?

    (a)   (b)   (c)   (d)
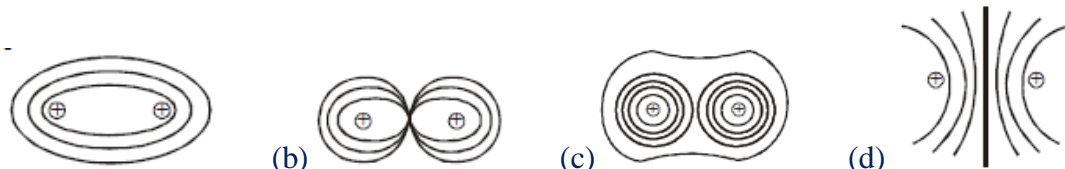
12. Four charges $q_1 = 2 \times 10^{-8}$ C, $q_2 = -2 \times 10^{-8}$ C, $q_3 = -3 \times 10^{-8}$ C, and $q_4 = 6 \times 10^{-8}$ C are placed at four corners of a square of side $\sqrt{2}$ m. What is the potential at the centre of the square?
    (a) 270 V   (b) 300 V   (c) Zero   (d) 100 V

13. The electric potential at point A is 1V and at another point B is 5V. A charge 3 μC is released from B. What will be the kinetic energy of the charge as it passes through A?
    (a) 8×10^{-6} J   (b) 12×10^{-6} J   (c) 12×10^{-9} J   (d) 4×10^{-6} J

14. A thin spherical conducting shell of radius R has a charge q. Another charge Q is placed at the centre of the shell. The electrostatic potential at a point P, a distance R/2 from the centre of the shell is
    (a) $\dfrac{2Q}{4\pi\varepsilon_0 R}$ (b) $\dfrac{2Q}{4\pi\varepsilon_0 R} - \dfrac{2Q}{4\pi\varepsilon_0 R}$ (c) $\dfrac{2Q}{4\pi\varepsilon_0 R} + \dfrac{q}{4\pi\varepsilon_0 R}$ (d) $\dfrac{(q+Q)^2}{4\pi\varepsilon_0 R}$

15. A large insulated sphere of radius r charged with Q units of electricity is placed in contact with a small insulated uncharged sphere of radius r' and is then separated. The charge on the smaller sphere will now be
    (a) $\dfrac{Q(r'+r)}{r'}$ (b) $\dfrac{Q(r'+r)}{r}$ (c) $\dfrac{Qr}{r'+r}$ (d) $\dfrac{Qr'}{r'+r}$

16. Electrical field intensity is given as $\vec{E} = (2x+1)y\hat{i} + x(x+1)\hat{j}$. The potential of a point (1, 2) if potential at origin is 2 volt is,
    (a) 2 V   (b) 4 V   (c) – 2 V   (d) 0 V

17. The electric potential due to a small electric dipole at a large distance r from the centre of the dipole is proportional to
    (a) r   (b) 1/r   (c) $1/r^2$ (d) $1/r^3$

18. Two small identical metal balls of radius *r* are at a distance *a* from each other and are charged, one with a potential V_1 and the other with a potential V_2. The charges on the balls are :
   (a) $q_1 = V_1 a, q_2 = V_2 a$
    (b) $q_1 = V_1 r, q_2 = V_2 r$
    (c) $q_1 = \left(\dfrac{V_1 + V_2}{2}\right)a, q_2 = \left(\dfrac{V_1 + V_2}{2}\right)r$
    (d) $q_1 = -\dfrac{r}{a}(rV_2 - aV_1), q_2 = -\dfrac{r}{a}(rV_1 - aV_2)$

19. Choose the wrong statement about equipotential surfaces.

(a) It is a surface over which the potential is constant

(b) The electric field is parallel to the equipotential surface

(c) The electric field is perpendicular to the equipotential surface

(d) The electric field is in the direction of steepest decrease of potential

Topic 2: Electrostatic Potential Energy and Work Done in Carrying a Charge

20. When a positive charge q is taken from lower potential to a higher potential point, then its potential energy will

    (a) increase   (b) decrease   (c) remain unchanged (d) become zero

21. A square of side 'a' has charge Q at its centre and charge 'q' at one of the corners. The work required to be done in moving the charge 'q' from the corner to the diagonally opposite corner is

    (a) zero   (b) $\dfrac{Qq}{4\pi \in_0 a}$ (c) $\dfrac{Qq\sqrt{2}}{4\pi \in_0 a}$ (d) $\dfrac{Qq}{2\pi \in_0 a}$

22. An alpha particle is accelerated through a potential difference of 10^6 volt. Its kinetic energy will be

    (a) 1 MeV   (b) 2 MeV   (c) 4 MeV   (d) 8 MeV

23. A and B are two points in an electric field. If the work done in carrying 4.0C of electric charge from A to B is 16.0 J, the potential difference between A and B is

    (a) zero   (b) 2.0 V   (c) 4.0 V   (d) 16.0 V

24. A conductor carries a certain charge. When it is connected to another uncharged conductor of finite capacity, then the energy of the combined system is

    (a) more than that of the first conductor   (b) less than that of the first conductor

    (c) equal to that of the first conductor   (d) uncertain

25. If a unit charge is taken from one point to another over an equipotential surface, then

    (a) work is done on the charge   (b) work is done by the charge

    (c) work done on the charge is constant   (d) no work is done

26. A ball of mass 1 g carrying a charge 10^{-8} C moves from a point A at potential 600 V to a point B at zero potential. The change in its K.E. is

    (a) -6×10^{-6} erg   (b) -6×10^{-6} J   (c) 6×10^{-6} J   (d) 6×10^{-6} erg

27. A positive point charge q is carried from a point B to a point A in the electric field of a point charge + Q at O. If the permittivity of free space is e0, the work done in the process is given by

    (a) $\dfrac{qQ}{4\pi \in_0}\left(\dfrac{1}{a}+\dfrac{1}{b}\right)$ (b) $\dfrac{qQ}{4\pi \in_0}\left(\dfrac{1}{a}-\dfrac{1}{b}\right)$ (c) $\dfrac{qQ}{4\pi \in_0}\left(\dfrac{1}{a^2}-\dfrac{1}{b^2}\right)$ (d) $\dfrac{qQ}{4\pi \in_0}\left(\dfrac{1}{a^2}+\dfrac{1}{b^2}\right)$

28. There exists a uniform electric field E = 4×10^5 Vm^{-1} directed along negative x-axis such that electric potential at origin is zero. A charge of – 200 μC is placed at origin, and a charge of + 200 μC is placed at (3m, 0). The electrostatic potential energy of the system is

    (a) 120 J   (b) – 120 J   (c) – 240 J   (d) zero

29. Two insulating plates are both uniformly charged in such a way that the potential difference between them is $V_2 - V_1 = 20$ V. (i.e., plate 2 is at a higher potential). The plates are separated by $d = 0.1$ m and can be treated as infinitely large. An electron is released from rest on the inner surface of plate 1. What is its speed when it hits plate 2? ($e = 1.6 \times 10^{-19}$ C, $m_e = 9.11 \times 10^{-31}$ kg)

e   1   2
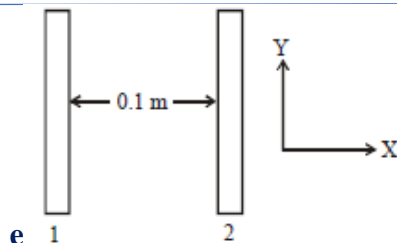
(a) 2.65×10^6 m/s   (b) 7.02×10^{12} m/s   (c) 1.87×10^6 m/s   (d) 32×10^{-19} m/s

30. Two positive charges of magnitude 'q' are placed, at the ends of a side (side 1) of a square of side '$2a$'. Two negative charges of the same magnitude are kept at the other corners. Starting from rest, if a charge Q moves from the middle of side 1 to the centre of square, its kinetic energy at the centre of square is

(a) zero   (b) $\dfrac{1}{4\pi \in_0} \dfrac{2qQ}{a}\left(1+\dfrac{1}{\sqrt{5}}\right)$ (c) $\dfrac{1}{4\pi \in_0} \dfrac{2qQ}{a}\left(1-\dfrac{2}{\sqrt{5}}\right)$ (d) $\dfrac{1}{4\pi \in_0} \dfrac{2qQ}{a}\left(1-\dfrac{1}{\sqrt{5}}\right)$

31. Two points P and Q are maintained at the potentials of 10 V and -4 V, respectively. The work done in moving 100 electrons from P to Q is:
(a) 9.60×10^{-17}J   (b) -2.24×10^{-16} J   (c) 2.24×10^{-16} J   (d) -9.60×10^{-17} J

32. Two identical thin rings each of radius R meters are coaxially placed at a distance R meters apart. If Q_1 coulomb and Q_2 coulomb are respectively the charges uniformly spread on the two rings, the work done in moving a charge q from the centre of one ring to that of other is

(a) zero   (b) $\dfrac{q(Q_1 - Q_2)(\sqrt{2}-1)}{\sqrt{2}.4\pi\varepsilon_0 R}$ (c) $\dfrac{q\sqrt{2}(Q_1 + Q_2)}{4\pi\varepsilon_0 R}$ (d) $\dfrac{q(Q_1 + Q_2)(\sqrt{2}+1)}{\sqrt{2}.4\pi\varepsilon_0 R}$

Topic 3: Charge and Capacitance of a Capacitor

33. The capacity of parallel plate capacitor depends on
(a) metal used to make plates   (b) thickness of plate
(c) potential applied across the plate   (d) area of plate

34. We increase the charge on the plates of a capacitor, it means,
(a) increasing the capacitance   (b) increasing P.D. between plates
(c) decreasing P.D. between plates   (d) no change in field between plates

35. If in a parallel plate capacitor, which is connected to a battery, we fill dielectrics in whole space of its plates, then which of the following increases?
(a) Q and V   (b) V and E   (c) E and C   (d) Q and C

36. A dielectric slab is inserted between the plates of an isolated charged capacitor. Which of the following quantities remain unchanged ?
(a) The charge on the capacitor   (b) The stored energy in the Capacitor
(c) The potential difference between the plates   (d) The electric field in the capacitor

37. A cylindrical capacitor has charge Q and length L. If both the charge and length of the capacitors are doubled by keeping other parameters fixed, the energy stored in the capacitor:
(a) remains same   (b) increases two times   (c) decreases two times (d) increases four times

38. To establish an instantaneous current of 2 A through a 1 mF capacitor ; the potential difference across the capacitor plates should be charged at the rate of :
(a) 2×10^4 V/s   (b) 4×10^6 V/s   (c) 2×10^6 V/s   (d) 4×10^4 V/s

39. Two identical metal plates are given positive charges Q_1 and Q_2 ($< Q_1$) respectively. If they are now brought close together to form a parallel plate capacitor with capacitance C, the potential difference between them is

(a) $\dfrac{Q_1 + Q_2}{2C}$ (b) $\dfrac{Q_1 + Q_2}{C}$ (c) $\dfrac{Q_1 - Q_2}{C}$ (d) $\dfrac{Q_1 - Q_2}{2C}$

40. A parallel plate capacitor with air between the plates has a capacitance of 8 pF. Calculate the capacitance if the distance between the plates is reduced by half and the space between them is filled with a substance of dielectric constant. ($\varepsilon_r = 6$)

(a) 72 pF   (b) 81 pF   (c) 84 pF   (d) 96 pF

41. A parallel plate air capacitor has a capacitance of 100 mF. The plates are at a distance d apart. If a slab of thickness t (t < d) and dielectric constant 5 is introduced between the parallel plates, then the capacitance will be

(a) 50 mF   (b) 100 mF   (c) 200 mF   (d) 500 mF

42. A uniform electric field $\vec{E}$ exists between the plates of a charged condenser. A charged particle enters the space between the plates and perpendicular to $\vec{E}$. The path of the particle between the plates is a :

(a) straight line   (b) hyperbola   (c) parabola   (d) circle

43. Force between two plates of a capacitor is

(a) $\dfrac{Q}{\varepsilon_0 A}$ (b) $\dfrac{Q^2}{2\varepsilon_0 A}$ (c) $\dfrac{Q^2}{\varepsilon_0 A}$ (d) None of these

44. An air capacitor of capacity C = 10 mF is connected to a constant voltage battery of 12 volt. Now the space between the plates is filled with a liquid of dielectric constant 5. The (additional) charge that flows now from battery to the capacitor is

(a) $120 \,\mu C$ (b) $600 \,\mu C$ (c) $480 \,\mu C$ (d) $24 \,\mu C$

45. A parallel plate capacitor with air between the plates is charged to a potential difference of 500V and then insulated. A plastic plate is inserted between the plates filling the whole gap. The potential difference between the plates now becomes 75V. The dielectric constant of plastic is

(a) 10/3   (b) 5   (c) 20/3   (d) 10

46. The gap between the plates of a parallel plate capacitor of area A and distance between plates d, is filled with a dielectric whose permittivity varies linearly from $\in_1$ at one plate to $\in_2$ at the other. The capacitance of capacitor is:

(a) $\in_0 \left(\in_1 + \in_2 \right) A / d$ (b) $\in_0 \left(\in_2 + \in_1 \right) A / 2d$

(c) $\in_0 A / \left[d \ln \left(\in_2 / \in_1 \right) \right]$ (d) $\in_0 \left(\in_2 - \in_1 \right) A / \left[d \ln \left(\in_2 / \in_1 \right) \right]$

47. The capacitance of a parallel plate capacitor is C_a (Fig. a). A dielectric of dielectric constant K is inserted as shown in fig (b) and (c). If C_b and C_c denote the capacitances in fig (b) and (c), then
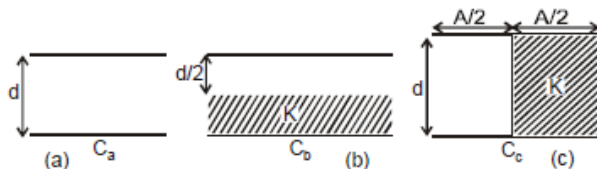

(a) both C_b, $C_c > C_a$ (b) $C_c > C_a$ while $C_b > C_a$ (c) both C_b, $C_c < C_a$ (d) $C_a = C_b = C_c$

48. A parallel plate air capacitor is charged to a potential difference of V volts. After disconnecting the charging battery the distance between the plates of the capacitor is increased using an insulating handle. As a result the potential difference between the plates

(a) does not change   (b) becomes zero   (c) increases   (d) decreases

49. 'n' identical drops, each of capacitance C and charged to a potential V, coalesce to form a bigger drop. Then the ratio of the energy stored in the big drop to that in each small drop is

(a) $n^{5/3} : 1$ (b) $n^{4/3} : 1$ (c) $n : 1$ (d) $n^3 : 1$

50. When a dielectric is introduced between the plates of a condenser, the capacity of condenser

(a) increases   (b) decreases   (c) remains same   (d) None of these

51. An unchanged parallel plate capacitor filled with a dielectric constant K is connected to an air filled identical parallel capacitor charged to potential V_1. If the common potential is V_2, the value of K is

(a) $\dfrac{V_1 - V_2}{V_1}$ (b) $\dfrac{V_1}{V_1 - V_2}$ (c) $\dfrac{V_2}{V_1 - V_2}$ (d) $\dfrac{V_1 - V_2}{V_2}$

Topic 4: Grouping of Capacitors and Energy Stored in a Capacitor

52. If there are n capacitors in parallel connected to V volt source, then the energy stored is equal to

(a) CV (b) $\dfrac{1}{2}nCV^2$ (c) CV^2 (d) $\dfrac{1}{2n}CV^2$

53. A sheet of aluminium foil of negligible thickness is introduced between the plates of a capacitor. The capacitance of the capacitor

(a) decreases   (b) remains unchanged   (c) becomes infinite   (d) increases

54. The work done in placing a charge of 8×10^{-18} coulomb on a condenser of capacity 100 micro-farad is

(a) 16×10^{-32} joule   (b) 3.1×10^{-26} joule   (c) 4×10^{-10} joule   (d) 32×10^{-32} joule

55. Two capacitors of capacitances C_1 and C_2 are connected in parallel across a battery. If Q_1 and Q_2 respectively be the charges on the capacitors, then $\dfrac{Q_1}{Q_2}$ will be equal to

(a) $\dfrac{C_2}{C_1}$ (b) $\dfrac{C_1}{C_2}$ (c) $\dfrac{C_1^2}{C_2^2}$ (d) $\dfrac{C_2^2}{C_1^2}$

56. In the given figure, the charge on 3 μF capacitor is
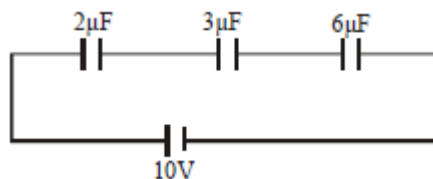
(a) 10 μC   (b) 15 μC   (c) 30 μC   (d) 5 μC

57. For the circuit shown in figure, which of the following statements is true?
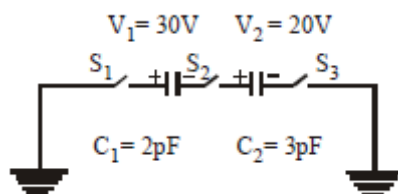
(a) With S_1 closed $V_1 = 15V$, $V_2 = 20V$ (b) With S_3 closed $V_1 = V_2 = 25$ V

(c) With S_1 and S_2 closed $V_1 = V_2 = 0$ (d) With S_1 and S_3 closed, $V_1 = 30$ V, $V_2 = 20$ V

58. The equivalent capacitance of the combination of the capacitors is
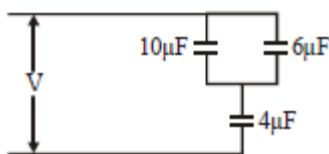
(a) 3.20μF   (b) 7.80μF   (c) 3.90μF   (d) 2.16μF

59. A capacitor has two circular plates whose radius are 8cm and distance between them is 1mm. When mica (dielectric constant = 6) is placed between the plates, the capacitance of this capacitor and the energy stored when it is given potential of 150 volt respectively are
(a) 1.06×10^{-5}F, 1.2×10^{-9} J
(b) 1.068×10^{-9}F, 1.2×10^{-5} J
(c) 1.2×10^{-9}F, 1.068×10^{-5} J
(d) 1.6×10^{-9}F, 1.208×10^{-5} J

60. In a charged capacitor, the energy is stored in
(a) the negative charges
(b) the positive charges
(c) the field between the plates
(d) both 'a' and 'b'

61. Three capacitors C_1, C_2 and C_3 are connected to a battery as shown in the figure. The three capacitors have equal capacitances. Which capacitor stores the most energy?
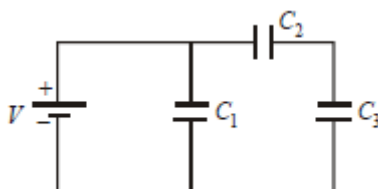
(a) C_2 or C_3 as they store the same amount of energy
(b) C_2
(c) C_1
(d) All three capacitors store the same amount of energy

62. Seven capacitors each of capacitance $2\,\mu F$ are to be connected in a configuration to obtain an effective capacitance of $\left(\dfrac{10}{11}\right)\mu F$. Which of the combination (s) shown in figure will achieve the desired result?
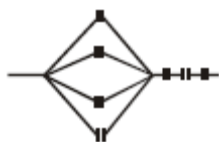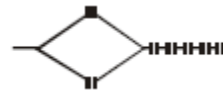
(a) (b) (c) (d)

63. A capacitor of capacitance $C_1 = 1\,\mu F$ can withstand maximum voltage $V_1 = 6kV$ (kilo-volt) and another capacitor of capacitance $C_2 = 3\,\mu F$ can withstand maximum voltage $V_2 = 4kV$. When the two capacitors are connected in series, the combined system can withstand a maximum voltage of
(a) 4kV
(b) 6kV
(c) 8kV
(d) 10kV

64. In the given network of capacitors as shown in Fig. given that $C_1 = C_2 = C_3 = 400$ pF and $C_4 = C_5 = C_6 = 200$ pF. The effective capacitance of the circuit between X and Y is
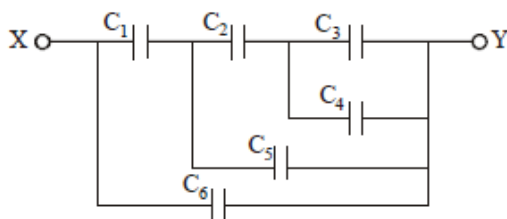
(a) 810 pF
(b) 205 pF
(c) 600 pF
(d) 410 pF

65. Three capacitors connected in series have an effective capacitance of 4μF. If one of the capacitance is removed, the net capacitance of the capacitor increases to 6 μF. The removed capacitor has a capacitance of :
(a) 2 μF
(b) 4 μF
(c) 10 μF
(d) 12 μF

NEET PREVIOUS YEARS QUESTIONS

1. The electrostatic force between the metal plates of an isolated parallel plate capacitor C having a charge Q and area A, is **[2018]**
    (a) independent of the distance between the plates
    (b) linearly proportional to the distance between the plates
    (c) inversely proportional to the distance between the plates
    (d) proportional to the square root of the distance between the plates

2. The diagrams below show regions of equipotential. **[2017]**

    (a)   (b) 10 V   30V   (c)   (d)
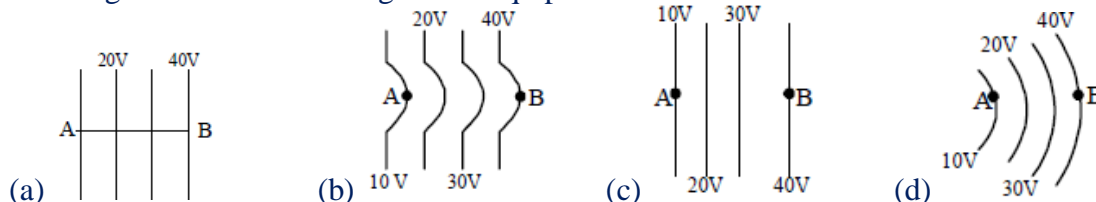
    A positive charge is moved from A to B in each diagram.
    (a) In all the four cases the work done is the same
    (b) Minimum work is required to move q in figure (a)
    (c) Maximum work is required to move q in figure (b)
    (d) Maximum work is required to move q in figure (c)

3. A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system: **[2017]**
    (a) decreases by a factor of 2   (b) remains the same
    (c) increases by a factor of 2   (d) increases by a factor of 4

4. A capacitor of $2\,\mu F$ is charged as shown in the diagram. When the switch S is turned to position 2, the percentage of its stored energy dissipated is : **[2016]**
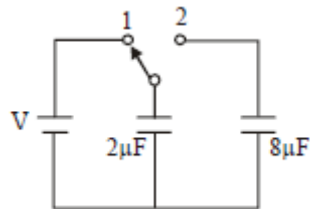
    (a) 0%   (b) 20%   (c) 75%   (d) 80%

5. A parallel plate air capacitor has capacity 'C' distance of separation between plates is 'd' and potential difference 'V' is applied between the plates. Force of attraction between the plates of the parallel plate air capacitor is : **[2015]**
    (a) $\dfrac{CV^2}{2d}$ (b) $\dfrac{CV^2}{d}$ (c) $\dfrac{C^2V^2}{2d^2}$ (d) $\dfrac{C^2V^2}{d^2}$

6. If potential (in volts) in a region is expressed as $V(x, y, z) = 6\,xy - y + 2yz$, the electric field (in N/C) at point (1, 1, 0) is: **[2015]**
    (a) $-\left(6\hat{i}+5\hat{j}+2\hat{k}\right)$ (b) $-\left(2\hat{i}+3\hat{j}+\hat{k}\right)$ (c) $-\left(6\hat{i}+9\hat{j}+\hat{k}\right)$ (d) $-\left(3\hat{i}+5\hat{j}+3\hat{k}\right)$

7. A parallel plate air capacitor of capacitance C is connected to a cell of emf V and then disconnected from it. A dielectric slab of dielectric constant K, which can just fill the air gap of the capacitor, is now inserted in it. Which of the following is incorrect ? **[2015]**
    (a) The energy stored in the capacitor decreases K times.
    (b) The chance in energy stored is $\dfrac{1}{2}CV^2\left(\dfrac{1}{K}-1\right)$
    (c) The charge on the capacitor is not conserved.
    (d) The potential difference between the plates decreases K times.

8. In a region, the potential is represented by $V(x, y, z) = 6x - 8xy - 8y + 6yz$, where V is in volts and x, y, z

are in metres. The electric force experienced by a charge of 2 coulomb situated at point (1, 1, 1) is: **[2014]**

(a) $6\sqrt{5}$ N (b) 30 N (c) 24 N (d) $4\sqrt{35}$ N

9. A conducting sphere of radius R is given a charge Q. The electric potential and the electric field at the centre of the sphere respectively are: **[2014]**

(a) Zero and $\dfrac{Q}{4\pi\varepsilon_0 R^2}$ (b) $\dfrac{Q}{4\pi\varepsilon_0 R}$ and Zero (c) $\dfrac{Q}{4\pi\varepsilon_0 R}$ and $\dfrac{Q}{4\pi\varepsilon_0 R^2}$ (d) Both are zero

10. Two thin dielectric slabs of dielectric constants K_1 and K_2 ($K_1 < K_2$) are inserted between plates of a parallel plate capacitor, as shown in the figure. The variation of electric field 'E' between the plates with distance 'd' as measured from plate P is correctly shown by : **[2014]**

(a) (b) (c) (d)
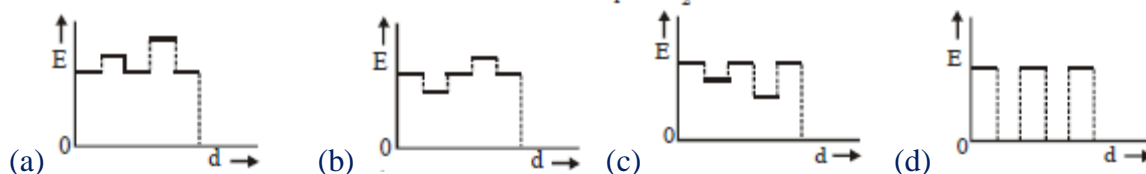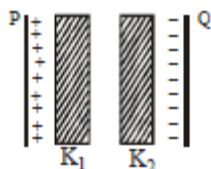
11. Two identical capacitors C_1 and C_2 of equal capacitance are connected as shown in the circuit. Terminals a and b of the key k are connected to charge capacitor C_1 using battery of emf V volt. Now disconnecting a and b the terminals b and c are connected. Due to this, what will be the percentage loss of energy ? **[NEET – 2019 (ODISSA)]**
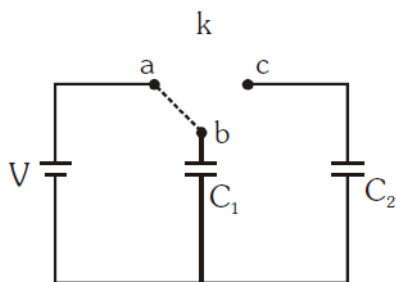
(1) 75% (2) 0% 3) 50% (4) 25%

12. The variation of electrostatic potential with radial distance r from the centre of a positively charged metallic thin shell of radius R is given by the graph **[NEET – 2020 (Covid-19)]**

(a) (b) (c) (d)
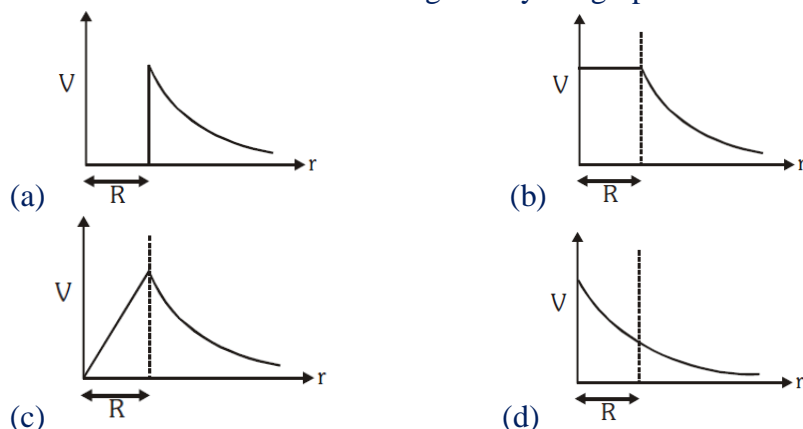
13. A parallel plate capacitor having cross-sectional area A and separation d has air in between the plates. Now an insulating slab of same area but thickness d/2 is inserted between the plates as shown in figure having dielectric constant K(= 4). The ratio of new capacitance to its original capacitance will be, **[NEET – 2020 (Covid-19)]**
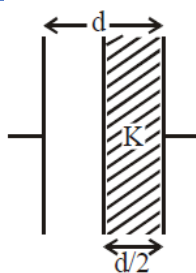
(1) 2 : 1   (2) 8 : 5   (3) 6 : 5   (4) 4 : 1

14. A short electric dipole has a dipole moment of $16 \times 10^{-9} Cm$. The electric potential due to the dipole at a point at a distance of 0.6m from the centre of the dipole situated on a line making an angle of 60^0 with the dipole axis is $\left(\dfrac{1}{4\pi\varepsilon_0} = 9 \times 10^9 Nm^2/c^2 \right)$ **[NEET – 2020]**

     1) zero   2) 50 V   3) 200 V   4) 400 V

15. In a certain region of space with volume 0.2 m^3 the electric potential is found to be 5V throughout. The magnitude of electric field in this region is   **[NEET – 2020]**

     1) 5 N/C   2) zero   3) 0.5 N/C   4) 1 N/C

16. The capacitance of a parallel plate capacitor with air as medium is $6\mu F$. With the introduction of a dielectric medium, the capacitance becomes $30\mu F$. The permittivity of the medium is $\left(\in_0 = 8.85 \times 10^{-12} C^2 N^{-1} m^{-2} \right)$ **[NEET– 2020]**

     1) $5.00 C^2 N^{-1} m^{-2}$ 2) $0.44 \times 10^{-13} C^2 N^{-1} m^{-2}$ 3) $1.77 \times 10^{-12} C^2 N^{-1} m^{-2}$ 4) $0.44 \times 10^{-10} C^2 N^{-1} m^{-2}$

17. Polar molecules are the molecules: **[NEET-2021]**

     1) acquire a dipole moment only in the presence of electric field due to displacement of charges.

     2) acquire a dipole moment only when magnetic field is absent.

     3) having a permanent electric dipole moment   4) having zero dipole moment.

18. Two charged spherical conductors of radius R_1 and R_2 are connected by a wire. Then the ratio of surface charge densities of the spheres (σ_1 / σ_2) is   **[NEET-2021]**

     1) $\dfrac{R_2}{R_1}$ 2) $\sqrt{\left(\dfrac{R_2}{R_1} \right)}$ 3) $\dfrac{R_1^2}{R_2^2}$ 4) $\dfrac{R_1}{R_2}$

19. A dipole is placed in an electric field as shown. In which direction will it move?   **[NEET-2021]**

     1)towards the right as its potential energy will decreases

     2)towards the left as its potential energy will decrease

     3)towards the right as its potential energy will increase

     4) towards the left as its potential energy will increase

20. A parallel plate capacitor has a uniform electric field '$\vec{E}$' in the space between the plates. If the distance between the plates is 'd' and the area of each plate is 'A' the energy stored in the capacitor is: (ε_0 = permittivity of free space)   **[NEET-2021]**

     1) $\varepsilon_0 EAd$ 2) $\dfrac{1}{2}\varepsilon_0 E^2 Ad$ 3) $\dfrac{E^2 Ad}{\varepsilon_0}$ 4) $\dfrac{1}{2}\varepsilon_0 E^2$

21. The equivalent capacitance of the combination shown in the figure is :   **[NEET-2021]**
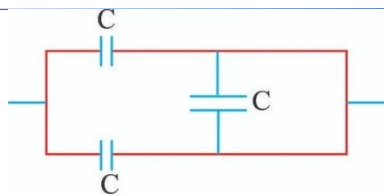
    1. $2C$ 2. $C/2$ 3. $3C/2$ 4. $3C$

22. Twenty seven drops of same size are charged at 220 V each. They combine to form a bigger drop. Calculate the potential of the bigger drop **[NEET-2021]**
1) 1320 V   2) 1520 V   3) 1980 V   4) 660 V

23. Two hollow conducting spheres of radii R_1 and R_2 $(R_1 \gg R_2)$ have equal charges. The potential would be **[NEET-2022]**
1) more on bigger sphere   2) more on smaller sphere
3) equal on both the spheres   4) dependent on the material property of the sphere
∴ V is more for smaller sphere

24. The peak voltage of the ac source is equal to: **[NEET-2022]**
1) The value of voltage supplied to the circuit   2) The rms value of the ac source
3) $\sqrt{2}$ time the rms value of the ac source   4) $1/\sqrt{2}$ times the rms value of the ac source

25. The angle between the electric lines of force and the equipotential surface is: **[NEET-2022]**
1) 0^0 2) 45^0 3) 90^0 4) 180^0

26. A capacitor of capacitance C = 900 pF is charged fully by 100 V battery B as shown in figure (a). Then it is disconnected from the battery and connected to another uncharged capacitor of capacitance C = 900 pF as shown in figure (b). The electrostatic energy stored by the system (b) is : **[NEET-2022]**
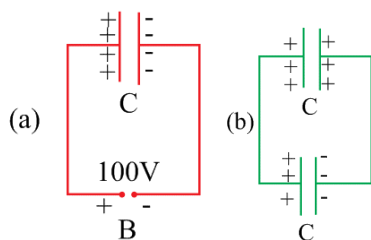
1) $4.5 \times 10^{-6} J$ 2) $3.25 \times 10^{-6} J$ 3) $2.25 \times 10^{-6} J$ 4) $1.5 \times 10^{-6} J$

NCERT LINE BY LINE QUESTIONS – ANSWERS

1) d   2) d   3) b   4) d   5) b   6) d   7) b   8) d   9) b   10) d
11) a   12) d 13) d 14) a 15) b 16) d 17) b 18) c 19) c 20) c
21) c   22) a 23) a 24) b 25) d 26) b 27) d 28) c 29) d 30) c
31) b   32) b 33) d 34) d 35) a 36) d 37) b 38) b

TOPIC WISE PRACTICE QUESTIONS - ANSWERS

1)	3	2)	2	3)	1	4)	3	5)	1	6)	2	7)	1	8)	4	9)	4	10)	3
11)	3	12)	1	13)	2	14)	3	15)	4	16)	3	17)	3	18)	4	19)	2	20)	1
21)	1	22)	2	23)	3	24)	2	25)	4	26)	3	27)	2	28)	1	29)	1	30)	4
31)	3	32)	2	33)	4	34)	2	35)	4	36)	1	37)	4	38)	3	39)	4	40)	4
41)	3	42)	3	43)	2	44)	3	45)	3	46)	4	47)	1	48)	3	49)	1	50)	1
51)	4	52)	2	53)	2	54)	4	55)	2	56)	1	57)	4	58)	1	59)	2	60)	3
61)	3	62)	1	63)	3	64)	4	65)	4										

NEET PREVIOUS YEARS QUESTIONS-ANSWERS

1)	1	2)	1	3)	1	4)	4	5)	1	6)	1	7)	3	8)	4	9)	2	10)	3
11)	3	12)	4	13)	2	14)	3	15)	2	16)	4	17)	3	18)	1	19)	1	20)	2
21)	1	22)	3	23)	2	24)	3	25)	3	26)	3								

TOPIC WISE PRACTICE QUESTIONS - SOLUTIONS

1. **(c)** Electric potential inside a conductor is constant and it is equal to that on the surface of conductor.

2. **(b)** At. equipotential surface, the potential is same at any point i.e., $V_A = V_B$ as shown in figure. Hence no work is required to move unit charge from one point to another i.e.,

$$V_A - V_B = \frac{W}{\text{unit ch arg e}} = 0 \Rightarrow W = 0$$

3. **(a)** The potential of uncharged body is less than that of the charged conductor and more than at infinity.

4. **(c)** Charge on the outer sphere $= q_1 = 4\pi R^2 \sigma$

Charge on the inner sphere $= q_2 = 4\pi r^2 \sigma$

$$v = \frac{1}{4\pi \in_0} \frac{q_1}{R} + \frac{1}{4\pi \in_0} \frac{q_2}{r}$$
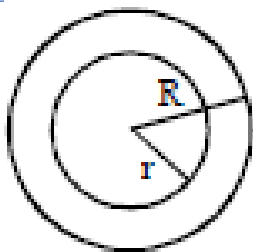
$$= \frac{1}{4\pi \in_0}\left[\frac{4\pi R^2 \sigma}{R} + \frac{4\pi r^2 \sigma}{r}\right] = \frac{4\pi\sigma}{4\pi \in_0}(R+r) = \frac{\sigma}{\in_0}(R+r)$$

5. **(a)** E = 500 V/m   V = 3000 V.

We know that electric field (E) = $500 = \dfrac{V}{d}$ or $d = \dfrac{3000}{500} = 6m$

6. **(b)** Here distance between a and +q= distance between C and −q=y_1 (say);
distance between a and −q= distance between C and +q=y_2
similarly , d(+q)=d(−q)=b(−q)=b(+q)=r (say)

Thus , $V_a = \dfrac{kq}{y_1} + \dfrac{-kq}{y_2}$

$V_b = \dfrac{kq}{r} + \dfrac{-kq}{r} = 0$

$V_c = \dfrac{kq}{y_2} + \dfrac{-kq}{y_1}$

$V_d = \dfrac{kq}{r} + \dfrac{-kq}{r} = 0$

Since $y_2 > y_1$, Va is positive Vc is negative.
Thus Va>Vb=Vd>Vc

7. **(a)** Let d- distance between any vertex and the center.
The potential at center before and after the charges are interchanged =

$$\frac{1}{4\pi\varepsilon}\frac{q}{d} + \frac{1}{4\pi\varepsilon}\frac{q}{d} + \frac{1}{4\pi\varepsilon}\frac{-q}{d}$$

Field initially at center $= 4\dfrac{1}{4\pi\varepsilon}\dfrac{q}{d^2}\cos\left(\dfrac{\pi}{4}\right)$ from A to C

Field at center after interchanging the charges $= 4\dfrac{1}{4\pi\varepsilon}\dfrac{q}{d^2}\cos\left(\dfrac{\pi}{4}\right)$ from C to A

The direction of field has changed

8. **(d)** In equilibrium, $F = qE = (ne)\dfrac{V}{d} = mg$

$$n = \frac{mgd}{eV} = \frac{1.96\times10^{-15}\times9.8\times0.02}{1.6\times10^{-19}\times800} = 3$$

9. **(d)** $V = 5 + 4x^2$ $\qquad \therefore \dfrac{dV}{dx} = 8x$ --------(1)

Force on a charge is

$F = qE = q\left(-\dfrac{dV}{dx}\right) = q(-8x)$

$= -2\times10^{-6}\times(-8\times0.5) = 8\times10^{-6}\,N$

10. **(c)** $V_{small} = k\dfrac{q}{r}$

If the radius of big drop is R,

$$\frac{4}{3}\pi R^3 = 1000\frac{4}{3}\pi r^3 \Rightarrow R = 10r$$

and charge of big drop, Q = 1000 q

Now $V_{big} = k\dfrac{Q}{R} = k\dfrac{1000q}{10r} = 100k\dfrac{q}{r} = 100V_{small}$

11. **(c)** Equipotential surfaces are normal to the electric field lines. The following figure shows the equipotential surfaces along with electric field lines for a system of two positive charges.

12. **(a) Conceptual**

13. **(b)** When the charge is released to move freely, the work done by electric field is equal to change in kinetic energy

$\therefore W_{EF} = \Delta KE \quad -q\Delta V = \Delta KE$

$KE = -3 \times 10^{-6}(1 - 5) = 12 \times 10^{-6}$ J

14. **(c)** Electric potential due to charge Q placed at the centre of the spherical shell at point P is

$$V_1 = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R/2} = \frac{1}{4\pi\varepsilon_0}\frac{2Q}{R}$$
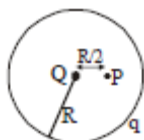
Electric potential due to charge q on the surface of the spherical shell at any point inside the shell is

$$V_2 = \frac{1}{4\pi\varepsilon_0}\frac{q}{R}$$

$\therefore$ The net electric potential at point P is

$$V = V_1 + V_2 = \frac{1}{4\pi\varepsilon_0}\frac{2Q}{R} + \frac{1}{4\pi\varepsilon_0}\frac{q}{R}$$

15. **(d)** Let the charge on the smaller sphere be q. As the potential of both will be the same finally,

$$\frac{q}{r^|} = \frac{Q-q}{r} \text{ or } q = \frac{Qr^|}{r+r^|}$$

16. **(c)**

$$V_{0\,0\,0} - V_{2\,1\,9} = \int_{0\,0\,0}^{2\,1\,9} y^2 dx + 2xy\,dy = \int_{0\,0\,0}^{2\,1\,9} d(xy^2)$$

$$= xy^2{}_{(0,0,0)}^{(2,1,9)} = 2$$

17. **(c)** Due to small dipole $V \propto \dfrac{1}{r^2}$

18. **(d)** $V_1 = \dfrac{1}{4\pi\in_0}\left[\dfrac{q_1}{r} + \dfrac{q_2}{a}\right]$ and $V_2 = \dfrac{1}{4\pi\in_0}\left[\dfrac{q_2}{r} + \dfrac{q_1}{a}\right]$
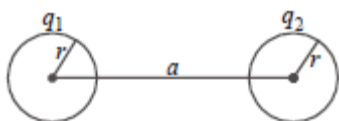
After solving above equations, and neglecting r^2 in comparison to a, we get

$$q_1 = -\frac{r}{a}(rV_2 - aV_1) \text{ and } q_2 = -\frac{r}{a}(rV_1 - aV_2)$$

19. **(b)** Electric lines of force are always perpendicular to an equipotential surface.

20. (a) Because work is to be done by an external agent in moving a positive charge from low potential to high potential and this work gets stored in the form of potential energy of the system. Hence, it increases.

21. **(a)** Here,
Hence, $V_A - V_B = 0$
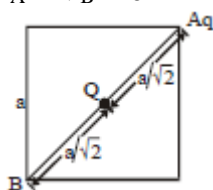
Work done, $W = q(V_A - V_B) = 0$

22. **(b)** Charge on a particle, $q = 2$ e.
K.E. = work done = $q \times V = 2e \times 10^6$ V = 2 MeV.

23. **(c)** Since $W_{A \to B} = q(V_B - V_A) \Rightarrow V_B - V_A = \dfrac{16}{4} = 4V$

24. **(b)** Energy will be lost during transfer of charge (heating effect).

25. (d) Since the potential at each point of an equipotential surface is the same, the potential does not change while we move a unit positive charge from one point to another. Therefore work done in the process is zero.

26. **(c)** As work is done by the field, K.E. of the body increases by
K.E. = $W = q(V_A - V_B) = 10^{-8} (600 - 0) = 6 \times 10^{-6}$ J

27. **(b)** $W_{BA} = q (V_A - V_B)$

$$= q\left[\frac{Q}{4\pi\varepsilon_0 a} - \frac{Q}{4\pi\varepsilon_0 b}\right] = \frac{qQ}{4\pi\varepsilon_0}\left[\frac{1}{a} - \frac{1}{b}\right]$$

28. **(a)** Potential energy of the system

$$U = q_1 V_1 + q_2 V_2 + \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r_2}$$

Now, V_1 [electric potential at origin] = 0
V_2 [electric potential at (3m, 0)] = $4 \times 10^5 \times 3 = 12 \times 10^5$
$\Rightarrow U = (+200) \times 10^{-6} \times 12 \times 10^5 + 9 \times 10^9$

$$\times \frac{\left(200 \times 10^{-6}\right) \times \left(-200 \times 10^{-6}\right)}{3} = 240 - 120 = 120J$$

29. **(a)** $eV = \dfrac{1}{2} mv^2 \Rightarrow v = \sqrt{\dfrac{2eV}{m}} = \sqrt{\dfrac{2 \times 1.6 \times 10^{-19} \times 20}{9.1 \times 10^{-31}}} = 2.65 \times 10^6 \, m/s$

30. **(d)** $U_i = \dfrac{2kqQ}{a} + \dfrac{2k(-q)Q}{\sqrt{5}a} = \dfrac{1}{4\pi\varepsilon_0}\dfrac{2qQ}{a}\left[1 - \dfrac{1}{\sqrt{5}}\right], \, U_f = 0$

By conservation of energy
Gain in KE= loss in PE

$$K = \frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left[1 - \frac{1}{\sqrt{5}}\right]$$

31. (c) potential difference=V=−4−10=−14V
Charge=q=100e =−1.6×10−17C

$$V = \frac{W}{q}$$

Now, potential difference,
$\Rightarrow$W=qV=−1.6×10^{-17}×(−14)
$\Rightarrow$W=2.24×10^{-16}J

32. **(b)** Work done $W_{21} = (V_1 - V_2)q$

$$V = \frac{1}{4\pi \in_0}\left[\frac{Q_1}{R} + \frac{Q_2}{\sqrt{2}R}\right] \text{ and } V_2 = \frac{1}{4\pi \in_0}\left[\frac{Q_2}{R} + \frac{Q_1}{\sqrt{2}R}\right]$$

Thus, $W_{21} = \dfrac{q(Q_1 - Q_2)(\sqrt{2}-1)}{\sqrt{2}.4\pi \in_0 R}$

33. **(d)**
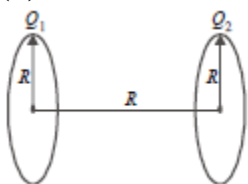
34. **(b)** $\because q \propto V$ for $q = CV$

   $\Rightarrow$ as charge on capacitor increases means P.D. between plates increases.

35. **(d)** Since battery remains connected so P.D. between the plates is constant. But as we introduce the dielectric, the capacitance increases and hence charge increases.

36. **(a)** Due to insertion of a dielectric slab capacitance increase by K times. The potential difference, the electric field and the stored energy decreases by 1/K times.

37. **(d)** increases four times

38. **(c)** As $C = \dfrac{Q}{V} = \dfrac{It}{V} \Rightarrow \dfrac{V}{t} = \dfrac{I}{C} = \dfrac{2}{1\times10^{-6}} = 2\times10^6\,V/s$

39. **(d)** The potential difference between the two identical metal plates is given as

   $C = \dfrac{\varepsilon_0 A}{d}$

   Let the surface charge density is given as

   $\sigma_1 = \sigma_2 = \dfrac{Q}{A}$

   The net electric field is

   $E_{net} = \dfrac{\sigma_1 - \sigma_2}{2\varepsilon_0}$

   We know the potential difference is given as
   V=E.d

   By substituting the above values we get $V = \dfrac{Q_1 - Q_2}{2C}$

40. **(d)** Capacity of parallel plate capacitor

   $C = \dfrac{\varepsilon_r \varepsilon_0 A}{d}$ \qquad (For air $\varepsilon_r = i$)

   So, $\dfrac{\varepsilon_0 A}{d} = 8\times10^{-12}$

   If $d \to \dfrac{d}{2}$ and $\varepsilon_r \to 6$ then new capacitance

   $C^| = 6\times\dfrac{\varepsilon_0 A}{d/2} = 12\dfrac{\varepsilon_0 A}{d} = 12\times8pF = 96pF$

41. **(c)** Capacitance will increase but not 5 times (because dielectric is not filled completely). Hence, new capacitance may be 200 mF.

42. **(c)** When charged particle enters perpendicularly in an electric field, it describes a parabolic path

   $y = \dfrac{1}{2}\left(\dfrac{QE}{m}\right)\left(\dfrac{x}{4}\right)^2$
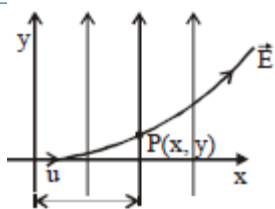
This is the equation of parabola.

43. **(b)** The magnitude of electric field by any one plate is

$\dfrac{\sigma}{2\varepsilon_0}$ or $\dfrac{Q}{2A\varepsilon_0}$

Now force magnitude is $|Q||E|$ i.e. $|F| = \dfrac{Q^2}{2A\varepsilon_0}$

44. **(c)** $q_1 = C_1 V = 10 \times 12 = 120 mC$

$q_2 = C_2 V = KC_1 \times V = 5 \times 10 \times 12 = 600\,\mu C$

Additional charge that flows $= q_2 - q_1 = 600 - 120 = 480\,\mu C$.

45. **(c)** $V_0 = \dfrac{q}{C_0}$ $V = \dfrac{q}{C} \Rightarrow \dfrac{V}{V_0} = \dfrac{C_0}{C} \Rightarrow \dfrac{C_0}{C} = \dfrac{500}{75} = \dfrac{20}{3}$

$C = kC_0 \Rightarrow k = \dfrac{20}{3}$ By definition,

46. **(d)** As the permittivity of dielectric varies linearly from ε_1 at one plate to ε_2 at the other, it is governed by

equation, $k = \left(\dfrac{\varepsilon_2 - \varepsilon_1}{d}\right)x + \varepsilon_1$ consider a small element of thickness dx at a distance x from plate. Then

$dV = \dfrac{E_0}{k}\, dx$

$\displaystyle\int_0^V dV = \int_0^d \dfrac{\sigma}{\varepsilon_0} = \dfrac{1}{\left(\dfrac{\varepsilon_2 - \varepsilon_1}{d}\right)x + \varepsilon_1}\, dx$

$V = \dfrac{d\sigma}{\varepsilon_0(\varepsilon_2 - \varepsilon_1)} \ln\left(\dfrac{\varepsilon_2}{\varepsilon_1}\right)$

$Q = CV \Rightarrow C = \dfrac{Q}{V} = \dfrac{\sigma A}{\dfrac{d\sigma}{\varepsilon_0(\varepsilon_2 - \varepsilon_1)} \ln\left(\dfrac{\varepsilon_2}{\varepsilon_1}\right)} = \dfrac{\varepsilon_0(\varepsilon_2 - \varepsilon_1)A}{d \ln\left(\dfrac{\varepsilon_2}{\varepsilon_1}\right)}$

47. **(a)**

$C_a = \dfrac{\in_0 A}{d}$ **and** $C_b = \dfrac{\in_0 A}{\dfrac{d}{2} + \dfrac{d}{2K}} = \dfrac{2\in_0 A(1+K)}{d}$

$C_c = \dfrac{\in_0 \dfrac{A}{2}}{d} + \dfrac{\in_0 \dfrac{A}{2}K}{d} = \dfrac{\in_0 A}{2d}(1+K)$ **or** $C_b = \dfrac{\in_0 A}{d}2(1+K) > C_a$ **or** $C_c = \dfrac{\in_0 A}{d}\dfrac{1+K}{2} > C_a$

$\therefore C_b$ and $C_c > C_a$

48. **(c)** If we increase the distance between the plates its capacity decreases resulting in higher potential as we know $Q = CV$. Since Q is constant (battery has been disconnected), on decreasing C, V will increase.

49. **(a)** Volume of big drop $= n \times$ volume of small drop

$$\frac{4}{3}\pi R^3 - n \times \frac{4}{3}\pi r^3$$

$R = n^{1/3}r$

Capacitance of small drop, $C = 4\pi\varepsilon_0 r$

Capacitance of big drop, $C = 4\pi\varepsilon_0 R = 4\pi\varepsilon_0 n^{1/3} r$; $C = n^{1/3}C$

The potential of small drop $V = q/C = \dfrac{q}{4\pi\varepsilon_0 r}$

The potential of big drop $V = \dfrac{q}{(4\pi\varepsilon_0 r)n^{1/3}r}$; $V = n^{2/3}V$

$\therefore$ Energy of small drop $= \dfrac{1}{2}CV^2$

Energy of big drop $= \dfrac{1}{2}CV^2 = \dfrac{1}{2}n^{1/3}C(n^{2/3}V)^2 = n^{5/3}\dfrac{1}{2}CV^2$

$\therefore \dfrac{Energy_{(big\ drop)}}{Energy_{(small\ drop)}} = \dfrac{n^{5/3}}{1}$

50. **(a)** Increase, because $C = \dfrac{K\varepsilon_0 A}{d}$

51. **(d)** As we know,

Common potential $= \dfrac{\text{Total charge}}{\text{Total capacity}}$

$Q_1 = C_0 V_1, Q_2 = 0$, therefore $V_2 = \dfrac{C_0 V_1 + 0}{C_0 + kC_0} = \dfrac{V_1}{1+k}$

$1 + k = \dfrac{V_1}{V_2}$ or $k = \dfrac{V_1}{V_2} - 1 = \dfrac{V_1 - V_2}{V_2}$

52. **(b)** The equivalent capacitance of n identical capacitors of capacitance C is equal to nC. Energy stored in this capacitor

$$E = \frac{1}{2}(nC)V^2 = \frac{1}{2}nCV^2$$
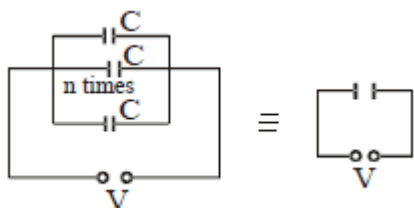
53. **(b)** The capacitance of a parallel plate capacitor in which a metal plate of thickness t is inserted is given by $C = \dfrac{\varepsilon_0 A}{d - t}$. Here $t \to 0 \therefore C = \dfrac{\varepsilon_0 A}{d}$

54. **(d)** The work done is stored as the potential energy. The potential energy stored in a capacitor is given by

$$U = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2} \times \frac{(8 \times 10^{-18})^2}{100 \times 10^{-6}} = 32 \times 10^{-32}\,\text{J}$$

55. **(b)** In parallel, potential is same, say V

$$\frac{Q_1}{Q_2} = \frac{C_1 V}{C_2 V} = \frac{C_1}{C_2}$$

56. **(a)** C = equivalent capacitance

$$\therefore \frac{1}{C} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} \Rightarrow \therefore C = 1\mu F$$

Charge in series circuit will be same.

$\therefore q = CV = (1 \times 10^{-6}) \times 10 = 10\,\mu C$

$\therefore$ Charge across '$3\mu F$' capacitor will be $10\mu C$.

57. **(d)** Initial charge on capacitors C_1 and C_2 is given by,

$q_1 = C_1 V_1 = 60$ pC $\quad q_2 = C_2 V_2 = 60$pC

When S_1 and S_3 are closed, capacitors C_1 and C_2 get connected in series. As a result charge on them should be same and so the charge do not redistribute on them. So potential on them remains same.

58. **(a)** Equivalent capacitance of two parallel capacitors $10\mu F$ and $6\mu F=(10+6)\mu F=16\mu F$ This $16\mu F$ capacitor is in series combination with $4\mu F$ capacitor,

$\therefore$ Equivalent capacitance of the entire combination $= \dfrac{16 \times 4}{16 + 4} = \dfrac{64}{20} = 3.2\,\mu F$

59. **(b)** Energy stored $= \dfrac{1}{2}CV^2 = \dfrac{1}{2} \times 1.068 \times 10^{-9} \times 150^2 = 1.2 \times 10^{-5}\,J$

$$C = \frac{KA\varepsilon}{\rho} = \frac{6 \times \left(\pi \left(\dfrac{8}{100} \right)^2 \right) \varepsilon_0}{1 \times 10^{-3}}$$

$$C = 6\pi \times \frac{64}{101} \times \frac{8.85 \times 10^{-12}}{10^{-3}} = (6 \times \pi \times 64 \times 8.85) \times 10^{-12-4+3}$$

$$= 10676.38 \times 10^{-13} = 1.0676 \times 10^{-9}$$

60. **(c)** Electrostatic energy of a condenser lies in the field in between the plates of the condenser.

61. **(c)** Potential drop across C_1 is maximum. Hence, energy stored in C_1 is maximum as energy $\propto$ (potential drop)^2.

62. **(a)** The equivalent capacitance
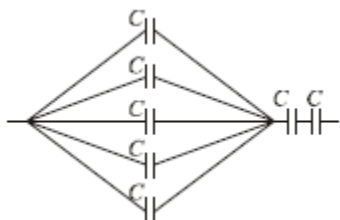
$$\frac{1}{C_{eq}} = \frac{1}{2} + \frac{1}{2} + \frac{1}{2 \times 5} = \frac{11}{10} \Rightarrow C_{eq} = \frac{10}{11}\,\mu F$$

63. **(c)** As $Q = CV$, $(Q_1)_{max} = 10^{-6} \times 6 \times 10^3 = 6mC$

While $(Q_2)_{max} = 3 \times 10^{-6} \times 4 \times 10^3 = 12mC$

However in series charge is same so maximum charge on C_2 will also be $6\ mC$ (and not $12\ mC$) and potential difference across it $V_2 = 6mC/3\,\mu F = 2kV$ and as in

series $V = V_1 + V_2$ so $V_{max} = 6kV + 2kV = 8kV$

64. **(d)** Start with C_2 and C_4 in parallel, then C_2 in series, then C_5 in parallel, then C_1 in series and finally C_6 in parallel.

65. **(d)** Let there are three capacitors with capacitances C_1, C_2, C_3 respectively and C_1 is removed.

In first case, $\dfrac{1}{C_{eq1}} = \dfrac{1}{C_1} + \dfrac{1}{C_2} + \dfrac{1}{C_3}$ -----------(1)

In second case, $\dfrac{1}{C_{eq2}} = \dfrac{1}{C_2} + \dfrac{1}{C_3}$ ------(2)

From (1) and (2), $\dfrac{1}{C_{eq1}} = \dfrac{1}{C_1} + \dfrac{1}{C_{eq2}}$

$$\frac{1}{4} = \frac{1}{C_1} + \frac{1}{6}$$

or $\qquad$ or $C_1 = 12\mu F$

NEET PREVIOUS YEARS QUESTIONS-EXPLANATIONS

1. **(a)** Electrostatic force between the metal plates

$$F_{plate} = \frac{Q^2}{2A_{\varepsilon_0}}$$

For isolated capacitor Q = constant

Clearly, F is independent of the distance between plates.

2. **(a)** As the regions are of equipotential, so Work done $W = q\Delta V$

ΔV is same in all the cases hence work - done will also be same in all the cases.

3. **(a)** When battery is replaced by another uncharged capacitor

As uncharged capacitor is connected parallel

So, $C^{|} = 2C$ and $V_c = \frac{q_1 + q_2}{C_1 + C_2}$; $V_c = \frac{q+0}{C+C} \Rightarrow V_c = \frac{V}{2}$
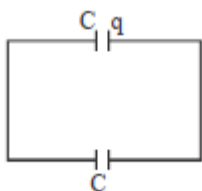
Initial Energy of system, $U_i = \frac{1}{2}CV^2$ ---------(i)

Final energy of system, $U_f = \frac{1}{2}(2C)\left(\frac{V}{2}\right)^2$ -------(i)

$= \frac{1}{2}CV^2\left(\frac{1}{2}\right)$; From equation (i) and (ii), $U_f = \frac{1}{2}U_i$

i.e., Total electrostatic energy of resulting system decreases by a factor of 2

4. **(d) When S and 1 are connected**

The $2\mu F$ capacitor gets charged. The potential difference across its plates will be V.

The potential energy stored in $2\mu F$ capacitor

$$U_i = \frac{1}{2}CV^2 = \frac{1}{2} \times 2 \times V^2 = V^2$$

When S and 2 are connected

The $8\mu F$ capacitor also gets charged. During this charging process current flows in the wire and some amount of energy is dissipated as heat. The energy loss is

$$\Delta U = \frac{1}{2}\frac{C_1 C_2}{C_1 + C_2}(V_1 - V_2)^2$$

Here, $C_1 = 2\mu F, C_2 = 8\mu F, V_1 = V, V_2 = 0$

$$\therefore \Delta U = \frac{1}{2} \times \frac{2 \times 8}{2+8}(V-0)^2 = \frac{4}{5}V^2$$

The percentage of the energy dissipated $= \frac{\Delta U}{U_i} \times 100 = \frac{\frac{4}{5}V^2}{V^2} \times 100 = 80\%$

5. **(a)** Force of attraction between the plates, F = qE

$$= q \times \frac{\sigma}{2\,\epsilon_0} = q \frac{q}{2A\,\epsilon_0} = \frac{q^2}{2\left(\dfrac{\epsilon_0\, A}{d}\right) \times d} = \frac{c^2 v^2}{2cd} = \frac{cv^2}{2d}$$

Here, $c = \dfrac{\epsilon_0\, A}{d}, q = cv, A = \text{area}$

6. **(a)** Potential in a region

$V = 6xy - y + 2yz$

As we know the relation between electric potential and

electric field is $\vec{E} = \dfrac{-dV}{dx}$

$$\vec{E} = \left(\frac{\partial V}{\partial x}\hat{i} + \frac{\partial V}{\partial y}\hat{j} + \frac{\partial V}{\partial z}\hat{k}\right)$$

$$\vec{E} = \left[\left(6y\hat{i} + (6x - 1 + 2z)\hat{j} + (2y)\hat{k}\right)\right]$$

$$\vec{E}(1,1,0) = -\left(6\hat{i} + 5\hat{j} + 2\hat{k}\right)$$

7. **(c)** Capacitance of the capacitor, $C = \dfrac{Q}{V}$

After inserting the dielectric, new capacitance $C^{|} = \dfrac{V}{K}$

New potential difference

$V^{|} = \dfrac{V}{K}$

$u_i = \dfrac{1}{2}cv^2 = \dfrac{Q^2}{2C} \ (\because Q = cV)$

$u_f = \dfrac{Q^2}{2f} = \dfrac{Q^2}{2kc} = \dfrac{C^2 V^2}{2KC} = \left(\dfrac{u_i}{k}\right)$

$\Delta u = u_f - u_i = \dfrac{1}{2}cv^2\left\{\dfrac{1}{k} - 1\right\}$

As the capacitor is isolated, so change will remain conserved p.d. between two plates of the capacitor

$L = \dfrac{Q}{KC} = \dfrac{V}{K}$

8 **(d)** $\vec{E} = -\dfrac{\partial V}{\partial x}\hat{i} - \dfrac{\partial V}{\partial y}\hat{j} - \dfrac{\partial V}{\partial z}\hat{j}$

$$= -\left[(6 - 8y)\hat{i} + (-8x - 8 + 6z)\hat{j} + (6y)\hat{k}\right]$$

At $(1, 1, 1) \vec{E} = 2\hat{i} + 10\hat{j} - 6\hat{k}$

$\Rightarrow (\vec{E}) = \sqrt{2^2 + 10^2 + 6^2} = \sqrt{140} = 2\sqrt{35}$

$\therefore F = q\vec{E} = 2 \times 2\sqrt{35} = 4\sqrt{35}$

9. **(b)** Due to conducting sphere

At centre, electric field $E = 0$

And electric potential $V = \dfrac{Q}{4\pi\,\epsilon_0\, R}$

10. **(c)** Electric field, $E \propto \dfrac{1}{K}$

As $K_1 < K_2$ so $E_1 > E_2$

Hence graph (c) correctly dipicts the variation of electric field E with distance d.

11. $U_{initial} = \dfrac{1}{2}CV^2$

$Loss = \dfrac{C.C}{2(C+C)}(V-0)^2 = \dfrac{1}{4}CV^2$

$\% Loss = \dfrac{\dfrac{1}{4}CV^2}{\dfrac{1}{2}CV^2} \times 100 = 50\%$

12. $V_{in} = V_S = \dfrac{KQ}{R}$ and $V_{out} = \dfrac{KQ}{r}(r > R)$
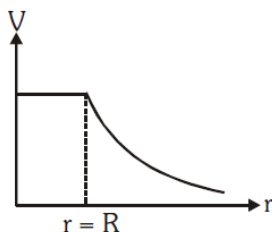
13. $C_O = \dfrac{\varepsilon_0 A}{d}$

$C_K = \dfrac{\varepsilon_0 A}{d - t + \dfrac{t}{k}} = \dfrac{\varepsilon_0 A}{d - \dfrac{d}{2} + \dfrac{d}{8}} = \dfrac{8}{5}\dfrac{\varepsilon_0 A}{d} = \dfrac{8}{5}C_O$

14. $V = \dfrac{KP\cos\theta}{r^2}$; $V = \dfrac{9 \times 10^9 \times 16 \times 10^9 \times \cos 60^0}{(0.6)^2}$
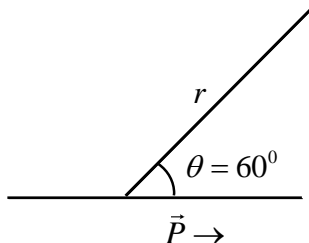
$V = \dfrac{9 \times 16 \times \dfrac{1}{2}}{0.36}$; $V = \dfrac{72}{0.36}$; $V = 200V$

15. Through out the volume electric potential is constant

V = constant $\Rightarrow dV = 0$

$\therefore E = \dfrac{-dV}{dr} = 0$

16. $\dfrac{\epsilon_0 A}{d} = 6\mu F$ …. (1)

$\dfrac{\epsilon A}{d} = 30\mu F$ ….. (2)

$$\frac{(2)}{(1)} = \frac{\in}{\in_0} = 5 \Rightarrow \in = 5 \in_0$$

$$= 5 \times 8.85 \times 10^{-12} = 44.25 \times 10^{12} \approx 0.44 \times 10^{-10} C^2 N^{-1} m^{-2}$$

17. having a permanent electric dipole moment

18. For same potential $\dfrac{q_1}{q_2} = \dfrac{R_1}{R_2}$

$$\frac{\sigma_1}{\sigma_2} = \frac{q_1}{q_2} \cdot \frac{R_2^2}{R_1^2} = \frac{R_2}{R_1}$$

19. $u = -PE\cos\theta = PE$

20. $\dfrac{1}{2} \rho V^2 \quad ; \quad \Rightarrow \dfrac{1}{2} \dfrac{\in_0 A}{d} \cdot E^2 d^2 = \dfrac{1}{2} \in_0 E^2 Ad$

21. 3rd capacitor is short circuited ; Ceq=2C

22. Electric potential due to a charged sphere $= \dfrac{kQ}{R}$

$k = 9 \times 10^9$ N–m²/C²
Q : charge on sphere
R : Radius of sphere
Let charge and radius of smaller drop is q and r respectively

For smaller drop, $V = \dfrac{kq}{r} = 220V$

Let R be radius of bigger drop,

As volume remains the same $\left(\dfrac{4}{3}\pi r^3\right) \times 27 = \dfrac{4}{3}\pi R^3 \Rightarrow R = \sqrt[3]{27}r = 3r$

Now, using charge conservation,
$\Rightarrow Q = 27q$

$$V_{big\,drop} = \frac{kQ}{R} = \frac{k(27q)}{3r} = 9\left(\frac{kq}{r}\right) = 9 \times 200 = 1980V$$

23. $V \propto \dfrac{1}{R}$

24. $V_{rms} = \dfrac{V_0}{\sqrt{2}}$

$V_0 = \sqrt{2} V_{rms}$

25. Electric lines of force are perpendicular to equipotential surface
$\therefore \theta = 90^0$

26. Common potential (V')

$$V' = \frac{CV + 0}{2C} = \frac{V}{2} = \frac{100}{2} = 50V$$

Energy stored in the system

$$\frac{1}{2}CV_1^2 \times 2 = \left(\frac{1}{2}CV_1^2\right) \times 2 = \frac{CV^2}{4} = \frac{900 \times 10^{-12} \times (100)^2}{4} = 2.25 \times 10^{-6} J$$

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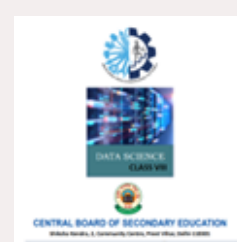
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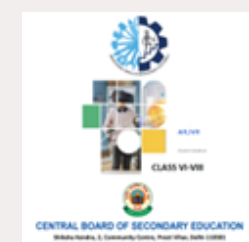
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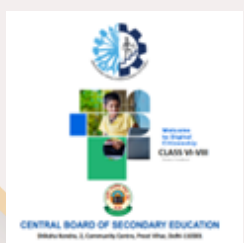
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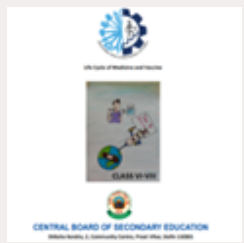
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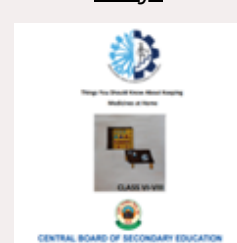
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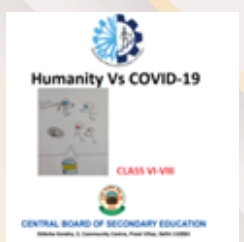
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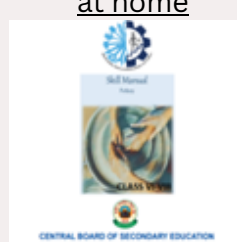
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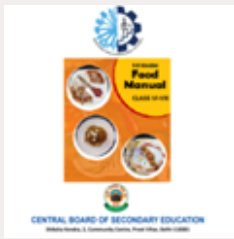
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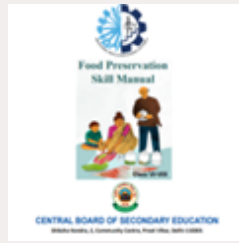
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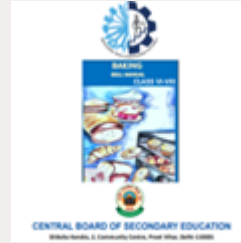
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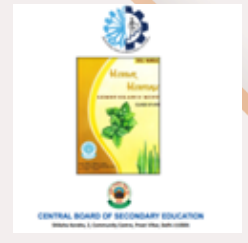
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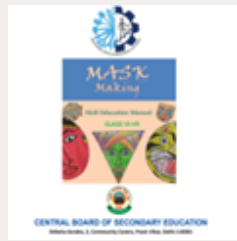
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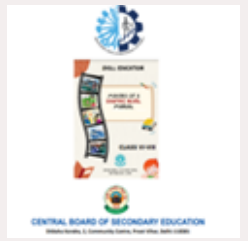
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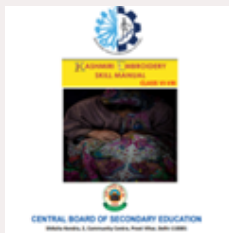
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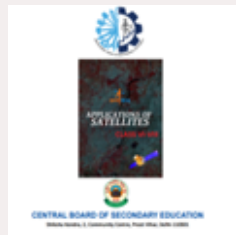
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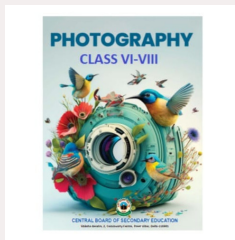
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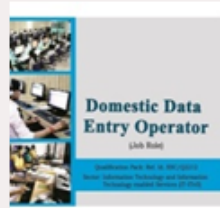
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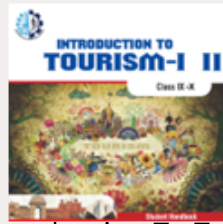
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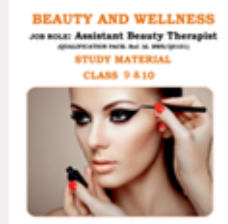
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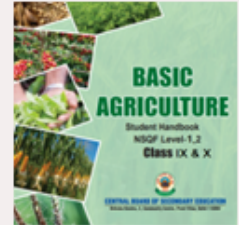
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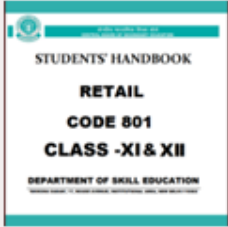
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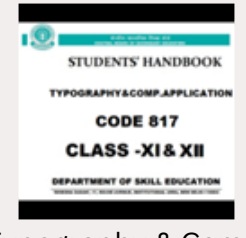
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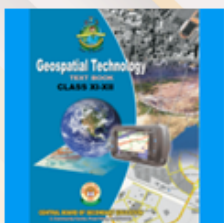
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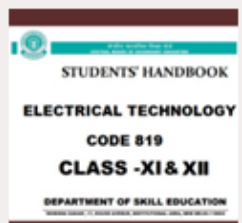
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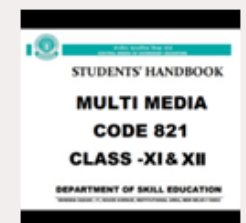
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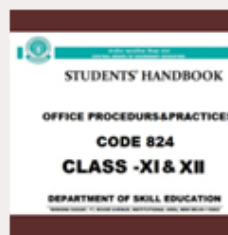
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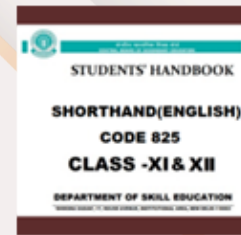
Shorthand (English)
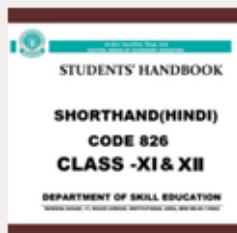
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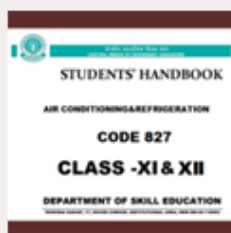
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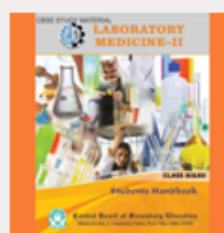
Medical Diagnostics
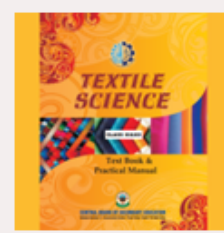
Textile Design

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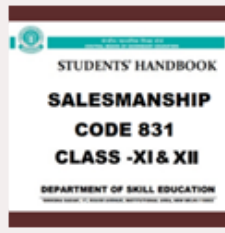
Salesmanship
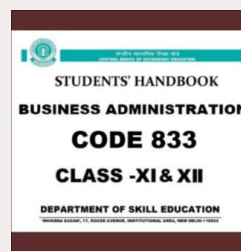
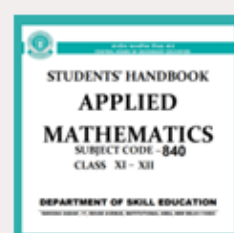Business Administration
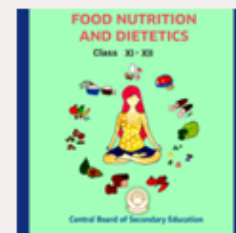
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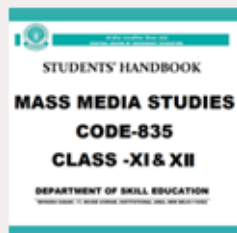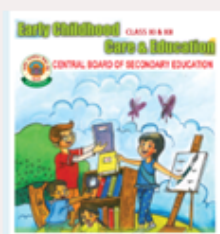
Mass Media Studies
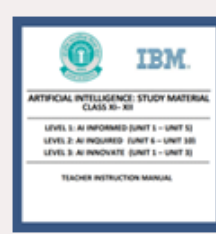
Library & Information Science
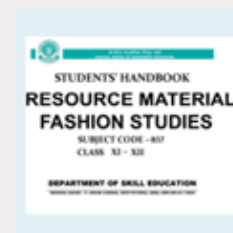
Fashion Studies

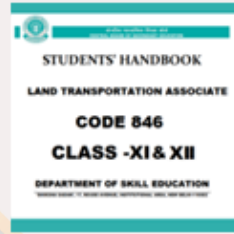Applied Mathematics

Yoga

Early Childhood Care & Education

Artificial Intelligence

Data Science

Physical Activity Trainer(new)

Land Transportation Associate (NEW)

Electronics & Hardware (NEW)

Design Thinking & Innovation (NEW)